



January 18, 2011

Mr. Jeffrey Zappieri
Supervisor, Consistency Review
Department of State
Office of Coastal, Local Government and Community Sustainability
99 Washington Avenue, Suite 1010
Albany, NY 12231-0001


Subject: **Updated Alternatives Analysis
Champlain Hudson Power Express Project**

Dear Mr. Zappieri:

On behalf of the Applicants, please consider this letter to be the response to your letter of November 22, 2010 which provided comments from the New York State Department of State (DOS) on the Updated Alternatives Analysis developed for the Champlain Hudson Power Express Project (Project) as well as requested additional information. We appreciate the comprehensive nature of your response.

The Applicants are in receipt of your letter of January 5, 2011 and expect to provide a formal supplement to our request for coastal consistency review of the Project at some point in the near future. Thank you again for your interest in the Project and, as always, our staff can be available at your convenience to discuss any questions or concerns arising from this document.

Sincerely,



Sean Murphy
Senior Regulatory Specialist

cc: D. Jessome, CHPEI (electronically)
F. Bifera, Hiscock and Barclay (electronically)

Champlain Hudson Power Express, Inc.

Case 10-T-0139

In a letter of November 22, 2010, the DOS requested additional information related to four topics:

- Analysis of alternate routes;
- Impacts associated with installation and operation of Project on commercial and recreational navigation;
- Impacts associated with installation and operation of Project on Significant Coastal Fish and Wildlife Habitats (SCFWH); and
- Impacts associated with installation and operation of Project on commercial and recreational fisheries.

Each of these areas of concern is discussed below.

1. Alternatives Analysis

As your letter notes, the Applicants have previously presented route alternatives as part of federal and state permitting processes. The Updated Alternatives Analysis report which was submitted to settlement parties on November 5, 2010 describes the routes. This document also provides an initial analysis of the three alternative routes presented by the New York State Department of Public Service (DPS) in late October.

In response to your letter, as well as to similar lines of questioning raised by other parties, the Applicants have endeavored to provide a detailed analysis of routing constraints and alternatives along the DPS' "Western Hudson Alternative". In order to allow for ease of analysis, the Western Hudson Alternative has been divided into segments with reference to the corresponding Route Mile marker to better aid in identifying the end points.

Segments of the route which were identified as being reasonable, as well as feasible, based on known concerns (e.g. engineering, land ownership, environmental constraints) have been accepted by the Applicants. In completing this analysis, the Applicants adopted the following principles:

- a. The minimization of in-water route length is not equivalent to minimizing environmental and societal impacts. Greater use of land-based corridors in these areas requires the crossing of a significant number of streams and wetlands, presenting the risk of greater cumulative impacts to resources. Available information indicates that the preferred in-water route will only have temporary impacts to the water bodies.
- b. Existing land corridors often involve construction complexities such as buried utilities and other existing infrastructure, the overcoming of which can be

economically infeasible. Even if economically feasible, these routes would significantly delay the Project's in-service date, impose significant inconvenience to vehicle and/or rail traffic for commuters, and leave the cables less reliable and more subject to outages and disruptions due to accidents, rail and highway repairs and maintenance, and terrorism risks.

- c. The multiple use of existing utility and transportation corridors has been a longstanding siting policy that now must be reconsidered in light of heightened concerns about terrorism. Increased security is required when installing new utility infrastructure in any new Right-of-Way (ROW). Submarine routes inherently offer enhanced security due to the absence of readily visible identification. Constructing a transmission line in its own ROW, rather than concentrating utility infrastructure in multiple use corridors, increases reliability by decreasing the chances that accidents and maintenance and repair work on other facilities will result in disruptions.
- d. When considering overland alternatives the preference is to utilize state highways rather than local roads due to the generally more expansive width of available rights-of-way, which allows for greater construction flexibility, increased worker safety, and decreased disruption of normal traffic flow. The Applicants also strongly preferred utilizing public lands for the cable corridor rather than establishing a permanent easement on private lands, although temporary easements may be necessary on private lands for construction purposes.

In terms of overland alternatives, parties have questioned in the past why existing utility corridors have not been utilized. In the Alternatives Analysis submitted with the July Supplement, a buried utility line extending from the U.S. / Canada border to the New York region was evaluated but ultimately eliminated from consideration. Since that time, the Applicants spoke with the three utilities who own the ROWs under discussion and each voiced opposition to collocation with their facilities. The New York Power Authority noted that they were under the same statutory restrictions as the New York State Canal Corporation in terms of their ability to dispose of public lands and that they do not believe they would have the ability to grant the necessary long term land interests. National Grid expressed concern regarding the impact this Project would have on their system reliability and potential expansion of their own facilities within the ROW. A representative of Con Edison stated that for safety and reliability reasons they would not want the cables installed in near proximity to their tower foundations. In addition, their transmission lines within Westchester County are buried and their representative did not believe Con Edison could grant the right to use their ROW to a separate private entity. These conversations have confirmed the Applicants' previous position that any attempt to collocate the Project with an existing utility ROW would require the acquisition of land rights adjacent to the ROW either through purchase or eminent domain due to concerns by the ROW owners over the safety of their system and their desire to preserve the ROW for potential future expansion.

Route Mile 202 to 223 (Coeymans to Catskill)

The Project route as originally proposed would enter the Hudson River in Coeymans, New York by following the CSX Transportation (CSX) ROW. The Applicants have reviewed the CSX

ROW from Selkirk south to north of Catskill and identified no significant engineering constraints. From Catskill, the Applicants would propose laying the cables within the Route 23 ROW to enter the river at approximately Mile 223.5 of the original route. This alternative bypassed several SCFWH areas, including Stockport Creek and Flats, Vosburg Swamp and Middle Ground Flats.

Route Mile 223 to 233 (Catskill to Malden-on-Hudson)

From Catskill to Malden-on-Hudson (north of Saugerties), the Applicants note only one potential engineering issue, the Catskill Trestle which crosses Catskill Creek and Route 9. Previous conversations with CSX suggest that the cables could be attached to this structure. Following the railroad ROW until it intersects with Route 34, the cables could be laid in the roadway ROW to the east to connect with Riverside Road and then Riverside Drive. While the Project in general seeks to avoid local roads due to the more narrow rights-of-way and potential for local opposition, the relative shortness of this usage seems justified given the length of overland that would be enabled. The parking lot for the boat launch at the termination of this road will allow for a horizontal directional drill (HDD) into the Hudson River.

The Applicants believe that this portion of the Western Hudson Alternative is a feasible alternative but that it is not possible to install the cables upland south of this point to Kingston for the reasons discussed below. Based on this analysis, the Applicants are including this segment in their overall settlement proposal.

Route Mile 233 to 245 (Malden-on-Hudson to Kingston)

Siting in this segment is complicated by the dense development within the Ulster / Kingston area. As the CSX railroad travels beneath Route 209 in Ulster, the railroad corridor is bound on either side by existing transmission lines. Typically when collocating in a common ROW, the utility companies must maintain a specified separation from other facilities, which would not be possible along this segment. This is one of the concerns raised by utility companies about collocating with existing transmission lines (see above for a more extended discussion). The route in this area would have to collocate in the ROW of John M. Clark Drive, which runs parallel to the tracks until they both intersect with Route 157, at which point the transmission lines no longer run on both sides of the railroad ROW. The utilization of the roadway does not represent an obstacle but is presented so as to be clear that the Applicants would need to leave the railroad ROW in this area.

After passing through the Kingston railyard and over Route 32/Flatbush Avenue, the railroad corridor traverses the middle of St. Mary's Cemetery with an overhead transmission line on the western side of the railroad corridor. There is insufficient room between the cemetery (actual gravestones) and the railroad tracks along the eastern side of the railroad corridor to install the Project's cables. A roadway bypass would require utilizing the Route 32 ROW to access Farrelly Street to the east or Foxhall Avenue to the west. Utilizing either of these roadways would require traveling through residential neighborhoods where the houses are tightly packed and close to the roads, making installation extremely difficult and disruptive.

Immediately south of the cemetery, the railroad corridor extends through a heavily developed urban area where large buildings are located immediately adjacent to the railroad corridor (within ~10 feet), resulting in insufficient horizontal clearance to install the Project cables within this section of ROW. This level of development is intermittent until the railroad crosses a small bridge over Broadway. As with the roads proximal to the cemetery, the roadways that might be utilized as an alternative to this segment (e.g. Foxhall Avenue, Cornell Street, Ten Broeck Avenue, and Grand Street) also have buildings immediately adjacent to the roadway as well as residential houses where construction would be disruptive.

The Applicants also reviewed roadway alternatives that would bypass the city of Kingston. Route 9W could be accessed by following Route 157 east at the terminus of John M. Clark Drive. While Route 9W has a low density of development north of Route 32, it becomes a limited access highway (controlled-access road) once it crosses Route 32. The New York State Department of Transportation (NYSDOT) has indicated that the Federal Highway Administration would need to review installation in this segment and that the last review required 18 months. Route 32 becomes Flatbush Road and Flatbush Avenue as it passes within the city center and experiences the same high level of development as other roadways within the city.

Based on this analysis, the Applicants were unable to identify any reasonable alternative that traversed the municipalities of Ulster and Kingston and therefore the cables will need to enter the water prior to this point. Moving north along the railroad ROW, the track runs parallel to the Hudson River until it intersects with Route 31, at which point it veers to the northeast towards Saugerties. As the Esopus Estuary SCFWH stretches along the riverbank north from where Esopus Creek empties into the Hudson River, the entry point would need to be in or north of Malden-on-Hudson. From the ROW, Route 34 could be followed to the east into Malden-on-Hudson and private land accessed to allow for an HDD into the Hudson at approximately Mile 233 of the original route.

In terms of roadway alternatives, the only road that travels in relatively close proximity to the Hudson River is Route 32 with a separation distance of approximately one-half mile. However, this roadway, as well as Route 9W, traverses the Esopus Creek Bridge to cross the Esopus Creek. To date, the New York State Department of Transportation has indicated that they would not permit hanging cables on structures owned and operated by the agency. An HDD would be complicated by the depth of the gorge (approximately 75 feet), the gravity dam downstream of the bridge, and existing buildings at both ends of the bridge. There are no existing launch /exit sites that meet the necessary spacing criteria for a safe drill under these constraints. Therefore, Routes 9W and 32 south of Esopus Creek are considered inaccessible to the northern portion of the cable route and therefore not a feasible alternative.

Route Mile 245 to 254 (Kingston to West Park)

South of Kingston, the access point to the railroad will require that the cables be installed within Rondout Creek, which is a SCFWH. Rondout Creek is one of the largest freshwater tributaries

of the Hudson River Estuary and the concentrations of anadromous and resident freshwater fish are considered unusual in Ulster County. In addition, the Applicants are aware of significant issues associated with a now defunct gasification plant at the mouth of the creek currently undergoing remediation. If installation of the cables were to occur in this water body, it should be done outside of the fish spawning and incubation periods (March through July for most warm water species). The railroad ROW does not appear to have any significant engineering constraints until it intersects with Route 9W in West Park.

The Applicants note that the ROW of Route 9W could also be utilized to travel north of Kingston. However, given that accessing the roadway would also require installation within the Rondout Creek SCFWH and that installation on a well-travelled road would be more disruptive than on a railroad line, the Applicants would recommend adopting the ROW alternative if it is determined that installation within the Rondout Creek is acceptable. The Applicants also considered utilizing Routes 81 /24 (River Road), which run parallel to the Hudson River but connecting to these roadways would require installing a significant length of the cable on privately-held land.

Route Mile 254 to 261 (West Park to Highland)

South of the intersection with Route 9W, the railroad line runs adjacent to the Hudson River and often the railroad lines are sited in a narrow opening between the edge of the Hudson River and large rock outcroppings or very steep terrain to the west. Installation in these areas will require either blasting of the bedrock to create a sufficient degree of separation from the railroad or an expensive HDD installation (assuming that there is available space for this technique). Using an internet mapping site that provided aerial photography, the Applicants identified sixteen distinct outcrops with an estimated average length 490 feet and a range of 230 to 1,020 feet. However, it should be noted that the desktop analysis only accounts for exposed outcroppings, so the actual extent of bedrock material may be far more extensive. In Highland, Oakes Road runs immediately adjacent to the railroad ROW for approximately 3,200 feet, so there is insufficient room to install the cables for much of this stretch. The Applicants consider installation in this section of railroad ROW to be at least impractical and likely infeasible.

The Applicants also considered the use of Route 9W, which initially travels through largely undeveloped countryside. Transmission poles border the western side of the road for less than 2 miles until it intersects with Upper North Road in Highland, so installation in this area would be on the eastern side. A short distance after the intersection with Upper North Road, Route 9W expands to four lanes. Over the next approximately 4 miles, the transmission system switches sides eight times. In order to maintain the required separation, the cables would need to cross underneath the roadway. As Routes 44 and 55 overlap with Route 9W in Highland, the transmission system poles occupy both sides of the roadway. In addition, the density of businesses with access points on the roadway increases. Route 9W also has two bridges before its connection with Route 44/55 for which there are no readily identifiable bypasses. The NYSDOT has indicated that there is no precedent for installation of a high voltage cable on a roadway bridge. The intensity of development as the highway enters Highland and high traffic volume would make utilization of Route 9W would make installation infeasible.

Route Mile 261 to 277 (Highland to Newburgh)

Immediately south of the intersection of the ROW with the Route 44 bridge, a maintenance road to the west of the tracks appears to have been built. The width of this road appears insufficient to meet CSX's minimum separation distance from the tracks. Between the Route 44 bridge and U.S. Highway 84 bridge in Newburgh, the Applicants identified eighteen rock outcrops that would significantly complicate installation if the railroad companies even allowed for the necessary construction activities. The average length of each outcrop is approximately 770 feet with a range of 160 to 2,950 feet. This segment also has seven instances where the railroad has water on both sides of the tracks for an average distance of 1250 feet. As was noted earlier, the desktop analysis only accounts for visible bedrock and so the actual length of ROW where upland construction is essentially infeasible may be far longer. A short distance south of the U.S. Highway 84 bridge the railroad occupies a raised berm. The cables would either need to be laid at the foot of the berm with HDDs for the road crossings or, in congested sections, the ROW of an alternate roadway such as Water Street would need to be accessed. The Applicants consider installation in this section of railroad ROW to be impractical.

In terms of roadway alternatives, Oakes Road passes under the Route 44 bridge but reaches a dead end within a mile. Other roadway route alternatives would need to be accessed through Highland and, as has been previously discussed; the level of development in the vicinity of the intersection of Routes 9W and 44 would prevent cable installation in a reasonable manner.

Following the Hudson River south from Highland, the first roadway to come in close proximity to the river is Old Indian Trail Road in Milton at approximately Route Mile 266. At its closest point, the road is adjacent to the railroad ROW and is less than a mile away from connecting to Route 9W. As Route 9W travels south, it traverses lightly to moderately developed areas. However, as was observed in a northern segment, the transmission poles cross the roadway multiple times which would require HDD drillings or open cut trenching at each location. The transmission line crossings are often to avoid natural and anthropogenic obstacles, thereby making installation of the Project's cables more problematic since cables would not only need to avoid the transmission lines but also these features.

As the road approaches Marlboro, development becomes more pronounced with the hamlet buildings directly adjacent to the roadway. South of the hamlet's center, the road has transmission poles on one side and a cemetery on the other for approximately 500 feet. Bypassing this section would require utilizing residential roads for approximately one-half mile. Continuing south, Route 9W continues to travel through low to moderate density developments, with transmission poles that cross the highway at infrequent intervals. The Applicants did not identify any engineering "fatal flaws" with this segment, but the high per-mile cost as well as the disruption to homes and businesses does not appear justified given the length of the bypass. In addition, as is discussed below, there are significant engineering constraints as the road passes beneath the Route 84 with no readily available bypass options.

Route Mile 277 to 280 (Newburgh to Cornwall-on-Hudson)

South of Newburgh, the Applicants did not identify any significant engineering constraints until the railroad reaches Cornwall-on-Hudson where Shore Road is proximal to the railroad tracks.

Within a one-half-mile distance of the Route 84 bridge, Route 9W experiences significant industrial development. In the center of Newburgh, the road is bordered by tightly packed residential homes, as well as occasional park and recreational facilities. South of Newburgh proper, Route 9W becomes a divided four lane highway for approximately 2 miles with transmission poles on the eastern side of the road. Once the divided highway ends, there is a bridge crossing of Moodna Creek which, based on previous conversations with NYSDOT about the use of their bridges, will require that the Project utilize an HDD drill as Route 9W crosses Route 107 in Cornwall, it transitions to a limited access highway and collocation of transmission cables in the ROW of limited access highways is highly restricted and discouraged by NYSDOT.

Route Mile 280 to 284 (Cornwall-on-Hudson to West Point)

As the railroad reaches Cornwall-on-Hudson, Shore Road runs parallel to the tracks for approximately 1 mile and for more than half that distance the Hudson River lies along the eastern side. The Applicants identified five rock outcroppings with an average length of 960 feet (range of 380 to 1,920 feet) and a berm through a water way extending approximately 300 feet. In West Point, River Road and the Upton Road run parallel to the railroad tracks with the Hudson River to the east for approximately 4,060 feet before entering the tunnel beneath West Point Military Academy. Given the engineering constraints presented over this relatively short segment, the Applicants do not consider it reasonable to utilize this route.

As previously discussed, Route 9W becomes a limited access highway in Cornwall and NYSDOT has indicated that it would likely restrict the collocation in the ROW of limited access highways. As an alternate route, the Applicants considered Route 218 which intersects the highway prior to the transition to a limited access roadway. Route 218, however, travels through the center of Cornwall-on-Hudson through tightly packed residential and commercial districts. Trees line both sides of road through the town, so that any installation would either require their removal or risk damage. Outside the town proper, Route 218 enters Storm King State Park and climbs up Storm King Mountain along a steep and windy roadway. As the road crosses the front of the mountain, there is an approximately one-half-mile stretch where the road has been carved out of the cliff face. Based on this engineering constraint, the Applicants do not consider this roadway to be a feasible alternative.

Route Mile 284 to 285 (West Point)

The tunnel beneath West Point extends for approximately 3,500 feet. The Applicants' insurance company has stated the cables must be fully protected to secure coverage. Installation of the cables within the tunnel ceiling would present a serious liability should any type of failure occur. Similarly, the railroad company has specified safety setbacks which could not be met within this

tunnel. Rock cuts into the sides of the wall are theoretically possible, although a geophysical analysis would be required to ensure there was no impact on the integrity of the tunnel. Past conversations with representatives of the railroad line suggest they would not allow this approach as it would require work within the tunnel for months, significantly impacting railway use. As the railroad leaves the tunnel, there is a short stretch (approximately 500 feet) where an Academy parking lot lies to the east and Williams Road to the west. The parking lot would need to be torn up to install the cables or an HDD enacted. The Applicants consider installation in this section of railroad ROW to be impractical.

There are no state roads in close proximity to either entrance to the tunnel. Both River Road and Upton Road are in close proximity to the water and connect into existing local roads; however, these roads are built perpendicular to the slope of the foothills of Storm King Mountain and the rights-of-way are narrow. In addition, the most likely alternatives are under the control of the Academy, which may not permit installation on a military facility. The Applicants believe that an in-water route is the most practical approach considering the short reach necessary to bypass this tunnel.

Route Mile 285 to 290 (West Point to Fort Montgomery)

As with earlier segments, the railroad runs parallel to the Hudson River. The Applicants identified ten rock outcroppings with an average length of 720 feet (range of 265 to 1,606 feet) and four water crossings with an average length of approximately 490 feet (range of 402 to 644 feet). In addition, the ROW travels through the Bear Mountain tunnel, which extends for approximately 800 feet. The Applicants consider installation in this section of railroad ROW to be impractical.

There are no state roads or local roads in close proximity to the water for this segment. Mine Dock Road in Fort Montgomery could be accessed if the cables came out of the water into the railroad ROW and were laid a short distance before entering the road; however, Mine Dock Road runs underneath Route 9W and private homes are located on either side of the bridge abutments. Therefore, the Applicants did not identify any overland alternative to this segment or specifically the Bear Mountain tunnel.

Route Mile 290 to 296 (Fort Montgomery to Haverstraw)

The Applicants identified six rock outcroppings with an average length of 490 feet (range of 190 to 860 feet) and seven water crossings with an average length of 1,080 feet (range 391 to 2,373 feet). In addition, north of Stony Point Lighthouse is an approximately 2,020-foot stretch of railroad where water is to the east and utility grade transmission lines are to the west. As the railroad curves around Dunderberg Mountain past Jones Point, River Road runs parallel to the tracks for approximately 1,400 feet. Further along the tracks, West Shore Drive in Tomkins Cove runs in close proximity to the railway for approximately 1,600 feet. The Applicants consider installation in this section of railroad ROW to be impractical due to the constrained ROW.

A steep rock embankment lies beneath the bridge that connects Route 6/202 into a round-about with Routes 9W/202 and the Palisades Interstate Parkway. The Applicants are unsure if this feature is considered part of the parkway and therefore unusable by a transmission system. Assuming Route 9W/202 is available, the roadway travels south through Bear Mountain State Park. Trees line both sides of the road, which is kept in a natural setting. The roadway passes a boat launch near Iona Island, whose bay is a SCFWH. The Applicants identified six rock outcroppings for an average length of 850 feet (range of 141 to 2,556 feet). The Applicants consider installation in this section of road to be impractical due to the extent of clearing, blasting and/or other activities that would be required within a state park for a relatively short overland segment.

Route Mile 296 to 303 (Haverstraw Bay)

The Applicants recently submitted a settlement proposal which would site the Project outside of Haverstraw Bay.

2. Commercial and Recreational Navigation

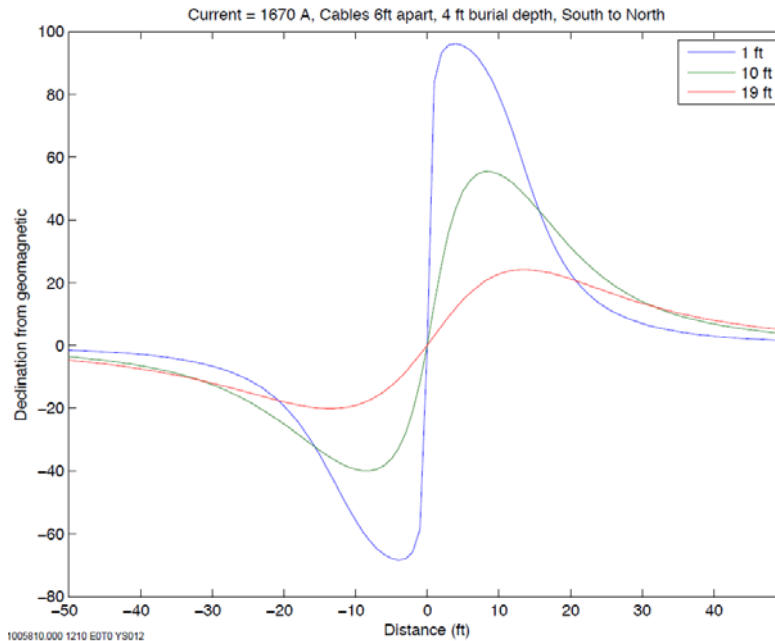
Impacts to commercial and recreational use of the waterways during the construction phase are expected to be minor and temporary. During Project construction, the presence and operation of the cable installation barges/vessels will create elevated noise levels and additional vessel traffic on these waterways. All Project work activities will be closely coordinated with the United States Army Corps of Engineers (USACE), the United States Coast Guard (USCG), local pilot associations and other local, state, and federal agencies as determined to be necessary to minimize or avoid impacts. A Notice to Mariners or similar notification will be issued prior to any in-water work.

Cables would be buried in a manner consistent with conditions and requirements imposed by the regulatory agencies; these conditions would include reasonably foreseeable maintenance and expansion activities associated with navigation channels. The presence of the cables will result in additional areas within these waterways where restrictions would be imposed on vessel anchorage. However, the proposed route avoids designated anchorage areas, so the overall impact is expected to be minor. The Applicants are not proposing to utilize the side slopes of the Federal navigation channel, as the overland routes proposed as part of settlement bypass those SCFWH where the DOS had previously identified it would be necessary to be in a disturbed area (e.g. Haverstraw Bay).

The DC magnetic field of the cables will not induce voltages or currents into communications equipment, including but not limited to marine radios, remote telephones, and cell phones. The only expected effect is a small effect on mechanical compasses when over the cables. An analysis by Exponent determined that, for cables buried at 4 feet and separated by a distance of 6 feet, the maximum deviance from magnetic north at 19 feet above the water would be an estimated 20 degrees at approximately 20 feet east or west from the cables (see Figure 1). The

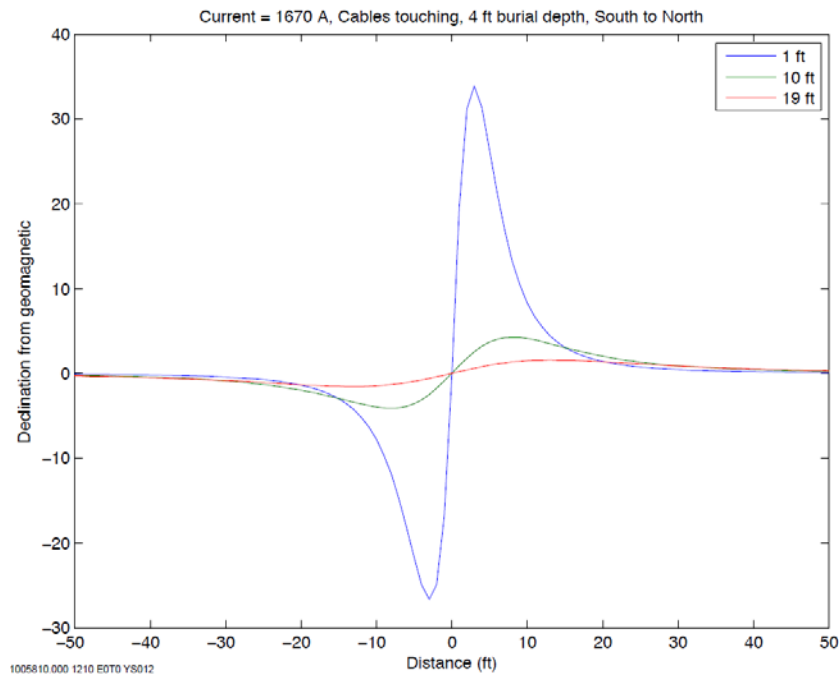
deviance from magnetic north is reduced to zero directly over the cables and at a distance of 50 feet from the cables.

Figure1: Deviation of a compass from magnetic north in degrees at 1, 10, and 19 feet above the sediment when cables are separated by 6 feet



The deviation of a compass from magnetic north was also estimated when the cables were in close proximity, as the Applicants are currently proposing. Under this scenario the expected declination from magnetic north would be less than 3 degrees at 19 feet above the cables and only within 10 to 20 feet of the cables (see Figure 2). As the cables are outside of the navigation channel (where vessel traffic will be heaviest) and the Hudson River is not open water, the impact of this deviance is expected to be minimal. Deeper burial of the cables would result in lowered effects.

Figure2: Deviation of a compass from magnetic north in degrees at 1, 10, and 19 feet above the sediment when cables are touching



In addition, there are no expected long term EMF exposure issues for individuals traveling along the Hudson River. The calculated magnetic field values at the surface of the Hudson River range from 38.7 to 57.3 milligauss (mG) [Appendix B, Request 14 of the supplemental document submitted to the New York State Public Service Commission on July 22, 2010]. This range is comparable to the expected magnetic field of a household appliance and considerably less than the earth's magnetic field (~470 to 590 mG). Current New York standards limit the maximum magnetic field at the end of a ROW of a major transmission line at 200 mG. None of the projected magnetic field exposures to commercial or recreational boaters would even remotely approach the limits recommended to protect human health by the International Commission on Non-ionizing Radiation Projection (NRPB, 2009).

3. Significant Coastal Fish and Wildlife Habitats

The potential impact of cable installation is addressed through an impairment test which evaluates the effects of the proposed action on a range of parameters that may be important in the ecological functioning of the designated habitat. The impairment test is used to determine if the proposed action would “destroy the habitat” or “significantly impair the viability of a habitat.” The parameters used in the test involve physical processes, chemical characteristics, including pollutants and biological assemblages and processes. The installation of the cables requires a temporary physical alteration to a small portion of the designated habitat, but the evaluation of habitat destruction or impairment can only be addressed in the long term because natural habitats have the documented capacity to recover from disturbances, both natural and man-induced. An evaluation of the potential impacts to the designated habitat is provided below.

Physical Parameters

The major physical parameters influencing habitat in the designated areas are the dynamic tidal character of the Estuary and the geological setting of the habitat. These factors interact to shape the river channel and control the substrate, which, in turn, are major determinants of the biological community and biological activity in each of the designated significant habitats. The burial of the cables will temporarily disturb a small portion of the substrates in these areas, but because no Project structures will remain above bottom after installation, the tidal dynamics and geological processes (erosion and sedimentation) would be unaltered by the installation work. The physical processes would act on the disturbed area and reshape the substrate material into the same general configuration as existed before the cables were installed.

The only instances where there would be a change in the topography of a habitat area would be in places where rock outcroppings required that the use of grout filled mattresses. These coverings would remain as a permanent feature on the bottom, extending several feet above the existing substrate, and would modify river currents in a very small area. While these structures could induce sedimentation and scour in the near vicinity, their overall effect on river currents, sedimentation and scour would be negligible as they would be located in deep, swift water that would continue to dominate the hydrodynamics of the reach. The Applicants anticipate providing information regarding potential installation depths throughout the entire underwater route as part of their response to the DOS letter of January 5, 2011.

Biological Parameters

The use of water jetting to bury the cables in the substrate would temporarily impact the benthic community and organisms in the path of the cables and those adjacent to the pathway may be buried by sediment that settles along the trench. Cable installation and burial equipment (e.g., jet plow, shear plow or similar equipment) moves at variable speeds across the bottom but slowly enough (generally less than 0.5 feet/second) so that fish and mobile invertebrates can move away and avoid direct effects. Adverse effects on benthic community structure, food chain relationships, species diversity and predator/prey relationships among benthic organisms and between the fish and benthic trophic levels would be restricted to the area of disturbance and would not occur throughout these trophic levels in the undisturbed deepwater portion of the designated habitat, nor would they occur beyond the area of disturbance in the Hudson Estuary as a whole. The limited spatial distribution of effects ensures that the adjacent undisturbed benthic habitat can provide a source of recruitment of reproductive stages that can recolonize the disturbed areas.

If it is necessary to cross the Federal navigation channel, conventional dredging may be required for cable installation below the channel's authorized depth. Because dredging would take place at the bottom of the existing deep channel, there would be very limited spread of dredged material turbidity laterally across the shallow habitat adjacent to the channel. Dredged material would be brought to the surface for placement in scows for transport to the selected disposal location. Conventional dredging would employ best management practices (BMPs). These

BMPs would limit the spread of a surface turbidity plume, minimizing turbidity and sedimentation effects on the adjacent shallow water. Dredging proceeds slowly across the bottom so that fish and mobile invertebrates can move away and generally avoid direct effects. The limited spatial distribution of effects ensures that the adjacent undisturbed benthic habitat can provide a source of recruitment of reproductive stages that can recolonize the disturbed area.

The recovery of the benthic community and the re-establishment of its ecological relationships with other trophic levels after cable installation is contingent upon the re-establishment of the benthic substrate which supports the benthic community. Installation of the cables disturbs the sediment in a very small area of any cable segment, but does not remove the substrate material except in cases where dredging is required. Much of the existing sediment remains in the trench created for the cables.

The availability of organic and inorganic suspended sediment and the action of the tidal current regime are the primary factors influencing the configuration of the substrate surface. These factors would be unchanged by cable installation and would begin to reshape the disturbed sediments immediately. The disturbed sediments would compact over time and the surface sediment particles would be re-sorted by current action and the trench area would be comprised of similar grain size distribution to surrounding substrates. Benthic substrates are a dynamic habitat in that they are changing in response to the variability in the forces that are constantly acting on them. Cable installation would have no influence on the variability of these factors, thus the substrate will retain its natural dynamic characteristics.

The population characteristics of the benthic organisms, such as reproductive rates, mortality rates and population size are the results of habitat and biological interactions occurring on a spatial scale much greater than the area affected by cable installation. The substrate disturbance would have a direct, temporary effect on the localized community in the path of the cables. However, with recovery of the habitat and re-colonization of the area, the populations of benthic species would return to pre-installation levels because the factors influencing the reproductive and mortality rates would be the same as the rates prevailing over the entire distribution of these species in the Estuary. The cable installation would not alter the factors controlling these rates.

Where grouted filled mattresses are employed, they would represent a new substrate material. However, as they would be used only where rocky substrate is exposed or close to the surface, in many cases the existing hard surface substrate would be replaced by an alternative hard surface material. The concrete of the mattresses would be colonized by aquatic life that prefers hard surfaces, thereby the net change in aquatic life using the substrate would be minimal. The presence of the mattresses would have no effect on biological activity occurring above the bottom, such as spawning of striped bass or migratory movements of fish. Overwintering of fish in these deep channels would continue to take place as it does under existing conditions.

Chemical Parameters

The chemical characteristics of the water in the designated habitat areas are determined by the water mass movements in the Estuary. The levels of chemical constituents change continually throughout tidal cycling. The Hudson Estuary is well mixed, thus the magnitude of changes over

a tidal cycle are generally relatively small. The installation process does not introduce or extract any chemical constituents from the water, which limits the potential for a change to the water chemistry to the disturbance of the substrate during cable installation.

The sediment chemistry for the designated habitat areas shows that the sediments have generally low and variable levels of chemical contaminants. These contaminants are widespread in the Estuary, thus existing aquatic life are exposed to them throughout their lifecycles. Water jetting would resuspend the existing substrate along the cable route, but as discussed above, the vast majority of the sediment would remain within the trench. In areas where dredging may be conducted when crossing through navigation channels, the dredge material would be tested and placed at an approved disposal site. The concentrations and distribution of the existing contaminants may be slightly altered by the sediment disturbance, but average concentrations of these constituents would remain the same throughout the designated habitat areas. Some contaminants that are in the surface layer would probably be buried as the disturbed sediment settles into the trench. Because the aquatic life exposure to existing contaminants is not significantly altered by the installation process, there will be no impairment of ecological processes.

During the Project planning phase, the Applicants are using existing sediment quality data to site the cable route and, where possible, avoid known areas of high concentrations of contaminants. In addition, water quality modeling is being conducted to assess the potential impacts to water quality standards. If, based on model results, there are potential impacts to water quality standards. The Applicants will develop methods to minimize the impact to the maximum extent practicable during installation. In addition, during cable installation, CHPEI will perform water quality monitoring to assure water quality standards are met.

A three-dimensional hydrodynamic and time-variable water quality model was developed to assess water quality impacts and compliance with water quality standards in the Hudson, Harlem and East Rivers. The model was used to simulate ten contaminants that were found in sediment cores collected during the Spring 2010 Marine Route Survey. The maximum model-computed concentrations of contaminants along the cable route were graphically presented and compared to New York State's water quality standards. The effects of the proposed cable installation are projected to comply with water quality standards that are based on protecting aquatic life from acute toxicity, which are the most appropriate criteria for the assessment of the proposed Project given the non-chronic (i.e., short-term) and incremental nature of the potential exposure to sediment contaminants resulting from the cable installation. The projected maximum total PCB concentration is below the EPA's Engineering Performance Standard water quality criteria for dredging resuspension at the Hudson River PCBs Superfund Site (EPA 2003).

Project Impacts

The submarine cable route presented in the July 2010 Supplement to the Application for Certificate of Environmental Compatibility and Public Need was developed using the following criteria selected to minimize potential impacts on aquatic resources:

- Cable route sited in moderately deep to deep water to avoid shallow vegetated habitats;
- Avoid maintained navigation channels to the extent possible;

- Avoid Significant Coastal Fish and Wildlife Habitats to the extent possible; and
- Use cable installation and burial equipment that minimizes disturbance of the benthic substrate.

Originally presented to state and federal agencies as almost an exclusively submarine project, early consultation indicated significant concerns with cable installation in the Hudson River north of the Federal Dam at Troy due to significantly elevated levels of PCB and the uncertainties surrounding the schedule for the Hudson River Dredging Project dredging activities initiated in 2010. The Applicants accepted the admonitions of these agencies and non-governmental organizations that an overland route for this portion of the route should be adopted to reduce potential water quality impacts despite the increased construction costs.

Recently, the Applicants have also proposed an additional 40 miles of upland routing as a replacement for approximately the same number of miles of in-water construction. In order to minimize water quality impacts and reduce the number of navigation channel crossings. This proposal, if adopted, would bypass the following SCFWH which were in proximity to the route presented in the July 2010 Supplement to the Application for Certificate of Environmental Compatibility and Public Need:

- Shad and Schermerhorn Islands
- Schodack and Houghtaling Islands
- Coeymans Creek
- Hannacroix Creek
- Mill Creek Wetlands
- Cocksackie Creek
- Cocksackie Island Backwater
- Stockport Creek and Flats
- Vosburg Swamp and Middle Ground Flats
- Haverstraw Bay
- Croton River and Bay

As discussed above, in their analysis of alternative routes the Applicants noted that there were no significant engineering constraints along the railroad ROW from Catskill to Malden-on-Hudson and have agreed to adopt this as part of their overall settlement proposal. The inclusion of this segment would mean the Project will bypass the following SCFWH:

- Rogers Island
- Catskill Creek
- Ramshorn Marsh
- Roeliff Jansen Kill
- Inbocht Bay and Duck Cove
- Germantown – Clermont Flat

Of the remaining SCFWH, the Applicants' route is adjacent to with nine resource areas and cross into six SCFWHs. In some cases the cable route passes close to the boundary of a SCFWH in the horizontal plane, but because of the criteria to place the cable in moderately deep to

deepwater, there is a substantial vertical separation of the installation corridor from the nearest SCFWH boundary. As discussed in the draft Best Management Practices (BMP) document submitted as part of the settlement process, the Applicants propose to use the following BMPs when installing the cable in and adjacent to SCFWH:

- **Seasonal Constraints:** It is anticipated that construction windows associated with in-water construction activities (i.e., dredging, cable laying, splicing, and burial activities) will be required by federal and state regulatory agencies. Regulatory agencies develop construction work windows in order to protect and minimize the potential impact on different species and on certain life stages. Within the Hudson River, the Department of State (DOS) has identified recommended work windows associated with SCFWHs. Table 1 identifies the expected work windows where the Project traverses the SCFWH areas. However, the Applicants recognize that seasonal construction windows may be imposed for areas where the Project comes in close proximity to other SCFWHs.
- **Limited Duration of cable installation:** The estimated duration of cable installation is relatively short in each SCFWH. Table 1 provides estimates of this time for each of the SCFWH where the Project traverse the habitat area.
- **Water Quality Monitoring:** The Applicants have proposed as part of settlement that jet plow trials with water quality monitoring in typical sediment conditions prior to installation to confirm BMPs for minimizing re-suspended sediment. In addition, water quality monitoring will be conducted during cable installation.
- **Water jetting operation parameter modifications:** If pre-installation water quality modeling indicates that there may be exceedances of water quality standards, modifications to the water jetting operation (including a reduction in water jetting pressure and a reduction in water jetting rate of installation) will be implemented. In addition, operational modifications may occur in the field based on water quality monitoring results.
- **Silt Curtains:** Silt curtains may be utilized in locations where proximal resources are considered particularly sensitive. The use of silt curtains and their location will depend on local hydrodynamics and navigation traffic.

Table 1: Agency Recommended Work Windows and Estimate Cable Installation Duration

Name	Recommended Closed Work Window	Estimated Cable Installation Duration (# days)
The Flats	Spring and Fall	5
Kingston Deepwater Habitat	N/A	9
Esopus Estuary	April-July (Warmwater fish spawning)	2
Poughkeepsie Deepwater Habitat	N/A	20
Hudson River Mile 44-56	May - July (striped bass spawning)	17
Lower Hudson Reach	Mid-November - Mid-April (Striped bass)	11

Route Refinements to Minimize Impacts

The Applicants' route crosses the following SCFWH because the habitat boundaries for one or more SCFWH extend from shore to shore or the SCFWH is located in the deep water portions of the Hudson River where the cables should be installed:

- Esopus Estuary
- The Flats
- Kingston Deepwater, Vanderburg Cove and Shallows, and Esopus Meadows Habitats
- Poughkeepsie Deepwater Habitat
- Hudson River Mile 44-56
- Lower Hudson Reach

The SCFWHs intersected by the cable contain similar physical conditions and similar important biological resources. Specific ecological values for these designated habitats include wintering and spawning habitat for shortnose sturgeon and important habitat for juvenile sturgeon. At Kingston and Poughkeepsie, the deepwater contains higher salinity water during the summer that provides the habitat for marine species that penetrate up the estuary. All SCFWHs would be important for migration during spring and fall. Spring migration could include adults of river herrings, American shad, and striped bass, in addition to shortnose sturgeon. Atlantic sturgeon also utilizes the estuary and would occur in these habitats or would migrate through them. American shad and striped bass spawn in these deepwater habitat or the adjacent shoals but their eggs and larvae are planktonic. A general description of expected impacts to these resource areas is provided below, followed by specific measures taken for each SCFWH.

Esopus Estuary

The Esopus Estuary SCFWH contains a complex of natural estuarine communities at the mouth of a major freshwater tributary of the Hudson River. The deepwater area is recognized as a post-spawning and wintering habitat for shortnose sturgeon. The littoral zone of the Hudson River adjacent to the creek mouth is also an important spawning ground for shad and serves as a spawning, nursery and feeding area for striped bass, white perch, herring, smelt, and most of the resident freshwater species.

Esopus Estuary also contains a number of shallow water habitats, but the proposed cable route avoids the Esopus river mouth and associated fresh-tidal wetlands and littoral zone areas. In the deepwater portion of the habitat, the original route spanned 1.24 miles. Recently the Applicants modified the route from Mile 235 to Mile 237 so that the centerline of the installation corridor was moved to the east when possible in order to further reduce the intersection with the habitat. This refinement not only shifts the centerline further from the mouth of Esopus Creek, it also reduces the length of cable route within the SCFWH to 0.31 miles in the deepwater portion of this SCFWH.

The utilization of the area by fish species can be protected by limiting installation work to existing work windows designed to protect these seasonal uses. Shortnose sturgeon favors the channel areas of the Hudson and has been shown to use both naturally deep and dredged channels. Cable installation would not alter channel depths or existing current regimes, and

following re-establishment of the benthic substrate the conditions that make this an important habitat for sturgeon would be unimpaired.

The Flats

The Flats is a large contiguous area of shallow, freshwater tidal flats. It serves as a spawning ground for American shad, with spawning occurring primarily on the extensive flats, shoals, sandbars and shallow areas near the mouths of tributary streams. The Flats also serve as spawning, nursery, and feeding habitat for striped bass, white perch, and various resident freshwater species. Shortnose sturgeon and Atlantic sturgeon may also use the area to feed (especially during slack water in late spring and summer).

For Route Miles 240.5 to 245.5, the route was modified so that the cables run along the western side of The Flats rather than the eastern. The western side is more heavily utilized as the maintained navigation channel occupies this portion of the river, so the cables will be sited along the maintained channel segment and the boundary of The Flats over a distance of approximately 0.5 miles at the northern end of the habitat. The Applicants would consider siting a silt curtain in this location, with the understanding that vessel traffic and hydrodynamics may present constraints. The silt curtain, if employed, would be in addition to BMPs such as seasonal restrictions and cable operational measures. Cable installation would not alter channel depths or existing current regimes, and following re-establishment of the benthic substrate the habitat value would be restored.

Kingston Deepwater, Vanderburg Cove and Shallows, and Esopus Meadows Habitats

The Kingston Deepwater SCFWH area contains six miles of continuous deep water from 30 feet deep to in excess of 50 feet deep. This deep water provides wintering habitat for shortnose sturgeon and supports spawning of sturgeon as well. With spawning occurring in this area, juveniles would also likely make use of this habitat. In addition, the higher salinity water in this deep section of the Estuary during summer low flows supports the upstream penetration of marine species in the Estuary.

For Route Miles 247 to 249, the centerline of the cable route was shifted slightly to the west to place it in deeper water between the Kingston Deepwater SCFWH and an area of shallow water. This refinement eliminates the only area in the original alignment where the cable route was in water less than 15 feet deep. In addition, a small reach of cable (Route Miles 252 to 252.75) was shifted to the east in order to remove it from the lower end of the Kingston Deepwater SCFWH.

The utilization of the area by fish species can be protected by limiting installation work to existing work windows designed to protect these seasonal uses. Shortnose sturgeon favors the channel areas of the Hudson and has been shown to use both naturally deep and dredged channels. Cable installation would not alter channel depths or existing current regimes, and following re-establishment of the benthic substrate the conditions that make this an important habitat for sturgeon would be unimpaired.

Poughkeepsie Deepwater Habitat

The Poughkeepsie Deepwater SCFWH area is a 14-mile reach of the Estuary containing a river bottom trench ranging from 30 feet deep to 50 feet deep over most of the area. A maximum

depth in excess of 125 feet occurs at Crum Elbow. This reach is spawning and wintering habitat for shortnose sturgeon, and marine fish species take advantage of the higher salinity water in the depths during low summer flows. The occurrence of larval shortnose sturgeon in this reach suggests that it may be important for juveniles of this species.

The Applicants are proposing three modifications to the original alignment in order to reduce the length of the Project within this habitat. For Route Miles 255 to 257.5, the cable route centerline was shifted to the east to place it between the boundary of the Poughkeepsie Deepwater SCFWH and shallow water along the east side of the river, thereby eliminating 1.9 miles of cable route within the SCFWH. Furthermore, the cable route was shifted to the east in Route Miles 264.5 to 265 to take advantage of relatively deep water outside the Poughkeepsie Deepwater Habitat. Finally, at the lower end of the Poughkeepsie Deepwater Habitat (Route Miles 267.5 to 268.5), the cables were shifted to the east so that the route was outside the SCFWH boundary for an additional approximately 1 mile.

The Poughkeepsie Deepwater is recognized as spawning and wintering habitat for shortnose sturgeon, an endangered species in the Hudson Estuary. Because sturgeon may be using this reach much of the year, installation would be scheduled when abundance in the area is low. The Applicants would consult with resource agencies on the best time to install cables in this reach. Shortnose sturgeon favors the channel areas of the Hudson and has been shown to use both naturally deep and dredged channels. Cable installation would not alter channel depths or existing current regimes, and following re-establishment of the benthic substrate the conditions that make this an important habitat for sturgeon would be unimpaired.

Hudson River Mile 44-56

Hudson River Mile 44-56 SCFWH is an approximate 12-mile reach of the Estuary where it passes through the Hudson Highlands. This is a narrow reach with very deep water, strong currents and extensive rocky bottom substrate. This reach is biologically significant because it remains freshwater through early summer and is a spawning area for striped bass and other anadromous species. The early juveniles of these species are carried through this reach to the productive shallows of Haverstraw Bay, Croton Bay and the Tappan Zee. In addition, this is a migration corridor for species moving upstream to the upper Estuary.

The recent survey of the cable route, including sub-bottom profiling, suggests that rock outcroppings are present in this reach of Estuary which may prevent burial of the cables. More refined profiling of the bottom would likely be undertaken before final placement of the cables. Where the cables cannot be buried, they would be laid across the bottom and covered with grout filled mattresses to protect them.

This deepwater area is recognized as a spawning area for striped bass and wintering habitat for shortnose sturgeon, an endangered species in the Hudson Estuary. These seasonal uses of the area can be protected by limiting installation work to existing work windows designed to protect these seasonal uses. Shortnose sturgeon favors the channel areas of the Hudson and has been shown to use both naturally deep and dredged channels. Cable installation would alter channel depths slightly where mattresses are used to protect the cables, but existing current regimes would remain as an important feature of this habitat area. These currents and recovery of the

substrate where the cable is buried would provide the conditions that make this an important habitat for striped bass and sturgeon.

Lower Hudson Reach

While this segment of the river has been heavily impacted by filling and development activities, it continues to support benthic, planktonic, and pelagic species. Striped bass in various life stages utilize the area for wintering between mid-November through mid-April. Yearling winter flounder can also be found wintering in this area during the same time period. In addition, several other fish species have been observed in surveys.

The utilization of the area by fish species can be protected by limiting installation work to existing work windows designed to protect these seasonal uses. The highest use of the habitat is during the winter season. Cable installation would not alter channel depths or existing current regimes, and following re-establishment of the benthic substrate the conditions that make this an important habitat for sturgeon would be unimpaired.

The installation of the Champlain-Hudson Power Express cables will not destroy SCFWH because the cables are buried and there will be no structures that could modify the natural processes that maintain the existing estuarine habitat community. A small portion of the deepwater habitat in the designated area will be temporarily impacted during and for a variable recovery time following the cable installation. Throughout installation and immediately after, the deepwater habitat will remain functional and will regain full ecological functionality through the action of unimpaired natural processes. In those small areas where concrete mattresses are used the change to habitat would be negligible and highly localized.

4. Commercial and Recreational Fisheries

The DOS has requested an assessment of the operational impacts of the Project on commercial and recreational fisheries. Once the cables are in place at the proper burial depth, the expectation based on numerous similar projects is that the in-water portion of the cables will be maintenance free. The only operational aspects of the cables with the potential to impact commercial and recreational fisheries are heat loss and electro-magnetic fields (EMF).

Heat Loss Effects

In its March application, the Applicants stated that there would be a negligible increase in the top 6 inches of sediment where the majority of benthic organisms reside. In response to a request from the DPS, the Applicants provided a coarse estimate of temperature rise at 0.2 meters below the seafloor assuming the cables were buried ~3 feet. The estimated average temperature rise associated with the HVDC cables would range from 1.20 degrees Celsius (°C) (gravel) to 1.50°C (sand) to 2.40°C (clay/silt) [Appendix B, Request 12 of the supplemental document submitted to the New York State Public Service Commission on July 22, 2010]. In response to an informal information request from the DOS, the Applicants applied the same formula for the HVAC cables resulting in a range of 0.70°C (gravel) to 2.30°C (clay/silt). For both cable systems, the

majority of heat was projected to be primarily dissipated through the sediments, below the sediment/water interface which is the biologically productive zone in the sediments.

In response to a further request made by the New York State Department of Environmental Conservation (NYSDEC), the Applicants contracted with Dr. William Bailey of Exponent to develop a more rigorous model of heat loss. This analysis examined the expected impacts on water temperature as well as sediment temperature and expected impacts on the biological community.

Water temperature

The average flow rate of water in the Hudson River is 13,600 cubic feet per second, but it can flow as slowly as 882 cubic feet per second¹. The energy loss from the cable in the form of heat that would be required to heat water moving at the average flow rate of the Hudson River by just 1°C is 6,000 Watts/meter (W/m) assuming a 150-mile cable length. Even at the minimum water flow of 882 cubic feet per second, a 1°C temperature increase would require a cable loss of 430 W/m². The typical anticipated cable loss when the transmission line is in operation is 86.2 W/m (43.1 W/m per cable for two cables). Thus, the heat from the cable will have a negligible perhaps even immeasurable effect on water temperature anywhere along the length of the proposed cable installation and any water quality or biological effects in the water column would similarly be negligible.

Further, one can compare the water heating due to the cable heat loss to the heating of the river by the energy from the sun. Solar energy deposited on the surface of the earth is approximately 3.7 kW-h/m² per day, with daily variation (standard deviation) of 2.2 kW-h/m².³ In the narrowest section of the Hudson River (992 feet), this produces average heating of 46,614 W/m with daily variation of 27,716 W/m; wider sections of the river will have a higher equivalent heating. The daily variation in the sun's heating is 321 times higher than the heating due to the proposed buried cables. The fluctuation in the sun's heat to the Hudson River over just one day is almost equivalent to a whole-year of heat loss from the installed cables. Hence, in any one day the heat input from the cable would be lost in the natural variability due to seasonal changes in length of daylight, meteorological conditions, and turbidity levels, and hence would have no water quality or biological effects within the water column.

Sediment temperature

Exponent performed a finite volume calculation of the temperature rise in the sediment below the seafloor surface. The model included two cables with heat losses of 43.1 W/m each, separated by 1.8 meters. The simulations were performed at cable burial depths of 3 feet (nominal burial depth), 6 feet (areas requiring additional protection), and 15 feet (crossing navigation channel).

¹ National Water Quality Assessment Program - The Hudson River Basin, <http://ny.water.usgs.gov/projects/hdsn/fctsht/su.html>.

² All the calculations assume that water had a chance to mix at least once in its travel along 150 miles of the river.

³ Based on the data of the closest U.S. Department of Energy National Renewable Energy Laboratory monitoring station at Bluefield, West VA; <http://www.nrel.gov/midc/bsc/>

Simulations were performed for three common sediment types: sand, clay, and gravel. The simulation was conservative in that it assumed that moving water provides no forced convection cooling of the seafloor sediment, only natural (i.e. standing water) convection and conduction of the sediment was included. In reality, moving water increases convection by assisting in the movement of heat out of the soil into the overlying water layer, which then passes away from the heat source by flow induced by the river gradient as well as tides or density changes.

Many different authorities use 2°K increase at 0.2 and 0.3 meter burial depth as a measure of cable induced heating (see Worzyk, 2009). For all burial depth and sediment types, the width of sediment which exceeds 2°K increase in temperature is less than 6 meters (18 feet) at depth of 0.2 and 0.3 meters below the seafloor surface. The seafloor surface temperature calculated in Tables 2 through 4 greatly overestimates the actual temperature rise due to the conservative assumptions of the model. Actual temperature rise on the seafloor surface is going to be by a far lower amount given the conservative assumption of non-flowing water. This model is more accurate, however, for the 0.2-and 0.3-meter depth calculations because the conservative assumption has less influence on the heat movement in the shallow subsurface sediment than at the sediment-water interface.

Table 2: Three Feet Cable Burial Depth

Soil Type	Thermal Resistivity (K-m/W)	Peak temperature rise (°K) @ 0.2 m Depth	Width of Sediment Above 2°K (m) @ 0.2m Depth	Peak temperature rise (°K) @ 0.3 m Depth	Width of Sediment Above 2°K (m) @ 0.3m Depth	Peak temperature rise (°K) @ seafloor surface	Width of Sediment Above 2°K (m) @ seafloor surface
Gravel	0.55	3.3	3.2	4.4	4	1.3	0
Sand	0.67	4.02	3.75	5.36	4.5	1.6	0
Clay/Silt	1	6	4	8	5	2.32	2.9

Table 3: Six Feet Cable Burial Depth

Soil Type	Thermal Resistivity (K-m/W)	Peak temperature rise (°K) @ 0.2 m Depth	Width of Sediment Above 2°K (m) @ 0.2m Depth	Peak temperature rise (°K) @ 0.3 m Depth	Width of Sediment Above 2°K (m) @ 0.3m Depth	Peak temperature rise (°K) @ seafloor surface	Width of Sediment Above 2°K (m) @ seafloor surface
Gravel	0.55	2.26	2.36	2.89	4.5	0.9	0
Sand	0.67	2.75	3	3.52	5	1.1	0
Clay/Silt	1	4.1	6	5.25	6	1.7	0

Table 4: Fifteen Feet Cable Burial Depth

Soil Type	Thermal Resistivity (K-m/W)	Peak temperature rise (°K) @ 0.2 m Depth	Width of Sediment Above 2°K (m) @ 0.2m Depth	Peak temperature rise (°K) @ 0.3 m Depth	Width of Sediment Above 2°K (m) @ 0.3m Depth	Peak temperature rise (°K) @ seafloor surface	Width of Sediment Above 2°K (m) @ seafloor surface
Gravel	0.55	1.18	0	1.45	0	0.5	0
Sand	0.67	1.44	0	1.77	0	0.67	0
Clay/Silt	1	2.15	2.86	2.65	5	0.96	0

More recently, Exponent considered the likely effect of both the cables touching (i.e. within the same trench) and being separated by 6 feet. The results are shown in the table below. As can be seen, the maximum temperature when the cables touch is higher than when there is a separation distance of 6 feet at the 0.2 and 0.3 meter depth. However, this delta becomes minimal at the seafloor surface.

Table 5: Maximum Temperature Change in Celsius for Two Cable Configurations

	6 Foot Separation	Cables Touching
Water	0.00021	0.0038
Surface	1.2	1.0
0.2 meter depth	3.4	5.2
0.3 meter depth	4.3	6.7

Impacts from Heat

Published calculations of the temperature effects of operating cables are consistent in their predictions of elevated temperatures in the near vicinity of the cables (OSPAR Commission 2009). The underwater cable buried below the seabed would not pose a physical barrier to fish passage, and would allow benthic organisms to colonize and demersal fish species (including demersal eggs and larvae) to utilize surface sediments without being affected by the cable operation (Mineral Management Service 2008). The small increase in seabed temperature is considered to be within normal ranges of variation and no residual effects are predicted. The potential for increases in seawater temperature above these areas is negligible and no significant effects are predicted (Shetland HVDC Connection 2009).

Specifically, the temperature requirement of river herring (alewife and blueback herring) eggs is between 7 to 29.5°C, with the optimum temperature preference at 18°C. In the Hudson River, the upper lethal temperature limit for eggs is 29.7°C. The upper lethal temperature in the Hudson River acclimated to 14°C was 31°C (Mullen et al. 1986).

Atlantic sturgeon eggs are highly adhesive and are deposited on the bottom substrate, usually on hard surfaces (e.g., cobble). Hatching occurs approximately 94-140 hours after egg deposition at temperatures of 20°C and 18°C, respectively, and larvae assume a demersal existence (Gilbert 1989; Atlantic Sturgeon Status Review Team 2007). There is no information on survival of eggs

or early life stages of shortnose sturgeon in the wild. Many eggs reared in captivity die of fungus infections. However, spawning in freshwater typically occurs when water temperature increase to 8-9°C and ceases when water temperature reach 12-15°C. Spawning in the Connecticut River has been observed to occur at 18°C (National Marine Fisheries Service 1998).

Hatching of white perch occurs in 24 hours at 16°C to 20°C and in 144 hours at 11 to 16°C. Optimum hatching temperature was 14°C at a salinity of zero parts per thousand (ppt). The size of newly hatched larvae was related to temperature; the maximum length occurred at 16 to 18°C at all salinities (0 to 10 ppt) (Stanley and Danie 1983).

The estimated peak temperature rise at the seafloor surface for the cables separated by 6 feet at the 3 feet cable burial depth ranges between 1.30 to 2.32°C, the 6 feet cable burial ranges between 0.9 to 1.7°C, and the 15 feet cable burial ranges between 0.5 to 0.96°C. However, these estimated rise in seafloor surface temperature are an overestimation of the natural condition as it does not taken into account the cooling effect from the natural flowing of the Hudson River. The potential rise in temperature of the seafloor surface will be within the preferred temperature limits of the demeral eggs and larvae species that utilizes the bottom habitat of the Hudson River Estuary.

EMF Effects

By way of background information, electric (E) fields can be blocked by conducting materials, such as the sheathing and insulation that is typically used in underwater power cables. Therefore, there is no direct exposure of marine species to E fields. In its EIS for the array of subsea cables for the proposed Cape Wind Energy Project, MMS (2009) reached the same conclusions as the USACE (2004), finding that E fields from cables would be eliminated by the shielding and that there would not negative effects to the aquatic community.

Emission of magnetic (B) fields is not prevented by cable sheathing, sediment, or other materials, and therefore a weak induced electric (iE) field will be generated within close proximity to a transmission cable. B and iE fields resulting from both direct and alternating currents decrease quickly to background levels with distance from the cable. Using an EPRI model, the USACE (2004), estimated the peak intensities of B fields anticipated from the proposed Cape Wind Energy Project in Massachusetts would be strongest at the seabed directly over the buried cables and would quickly attenuate to approximately 10 percent of the peak intensity within 10 to 20 feet directly above the seafloor and 20 to 30 percent of the peak intensity within 10 feet horizontally from the AC cables. While burying the cable does not prevent the emission of these fields, it does result in an added buffer, putting distance between the cable and the marine biota over which the emissions will decrease (Exponent and Hatch 2009).

The “EMF emissions” of the cables do not vary between the marine and freshwater aquatic environments as they are a function of the cable, not the surrounding environmental conditions. The electric field of the proposed cables is totally shielded from the aquatic environment by the grounded metallic and ferromagnetic sheaths surrounding the cables. The metallic and

ferromagnetic sheaths will slightly attenuate the magnetic field of the cables but the magnetic field measured outside the cables in the lake or riverbed or water column would not be affected by the salinity of the water (fresh, brackish, salt water).

The Applicants provided a discussion of EMF in the Exhibit 4 of the March 30, 2010 Application for Certificate of Environmental Compatibility and Public Need (Application). In this same document, an Electric and Magnetic Fields report was provided in Appendix H. In the supplement to the Application, the Applicants supplied a revised Electric and Magnetic Fields report that include the expected field levels for the HVAC cables [Response 14, Appendix B and Attachment M, Request 12 of the supplemental document submitted to the New York State Public Service Commission on July 22, 2010]. As discussed in Section 2 above, Exponent has also calculated expected magnetic fields at depths of 1, 10, and 19 feet above the sediment for cables that are buried six feet apart and touching. The Applicants also anticipate providing additional data in response to the DOS letter of January 5, 2011.

Concern over the EMF effects has focused on the potential for influencing migration patterns and exposure to the fields. In order to better understand the best available information on these two issues, the Applicants are providing a literature review below.

Migration

Previous studies have indicated that the weak iE field generated by a transmission cable is within the range of detectability of electrosensitive species (Normandeau and Exponent 2010, Exponent and Hatch 2009, Centre for Marine and Coastal Studies at the University of Liverpool 2003). In a controlled experiment, Gill et al. (2009) evaluated the response of three species of electro-sensitive fish (two shark species and one ray species) to a buried subsea cable. They found that while some of the elasmobranchs responded to the EMF emitted in terms of both the general spatial distribution of one of the species tested, and at the finer scale level of individual fish of different species, they stated that this response varied within the species and also during times the cable being energized and not energized, day and night (Gill et al. 2009). While electro-sensitive species may detect the EMF, the effects do not appear to be significant (Centre for Marine and Coastal Studies at the University of Liverpool 2005; Scott Wilson Ltd. and Downie 2003; Sound & Sea 2002; USACE 2004; MMS 2009; Scottish Executive 2007; World Health Organization 2005; Exponent and Hatch 2010). The Scottish Marine Renewables Strategic Environmental Assessment reported that “Current research indicates that certain species of elasmobranchs are likely to be able to detect the level of electric field that will be generated by a typical export cable but the field would not cause an avoidance reaction. Furthermore, there is no evidence to indicate that existing cables have caused any significant impact on elasmobranch migration patterns” (Scottish Executive 2007).

Studies have also investigated the effect of electric and magnetic fields on fish movement and migration. Some migratory animals, including sea turtles, Pacific salmon, Japanese eel (*Anguilla* species), and spiny lobster, are thought to detect and orient to the earth’s geomagnetic field during their travel (Lohmann et al. 2004, Hatch Acres 2006, Nishi et al. 2004, Karlsson 1985, Tesch et al. 1992), though it is thought that this is one of several potential mechanisms used for navigation (Groot and Maragolis 1998; Quinn et al. 1981). Crystals of magnetite have been

found in four species of Pacific salmon (Mann et al. 1988; Walker et al. 1988), and these crystals are thought to serve as a compass that orients to the earth's magnetic field (Valberg 2005, Scottish Executive 2007). In a study of chum salmon (*Oncorhynchus keta*) Yano et al. (1997) fit a tag that generated a 600 μ T artificial B field around the head of the fish; there was no observable effect on the horizontal and vertical movements of the salmon when the tag's magnetic field was varied. Quinn and Brannon (1982) found that while salmon are thought to detect B fields, their behavior is probably governed by various stimuli as evidenced by the lack of effect of changing artificial B fields. Similar results were found in studies of Atlantic salmon: research of EMF effects showed that navigation and migration of Atlantic salmon was not expected to be affected by the B field produced by an underwater cable (Scottish Executive 2007).

Within the Project area, potential aquatic species of concern include shortnose sturgeon, Atlantic sturgeon. Sturgeon are weakly electric fish and can use electroreceptor senses, along with other senses, to locate prey. In the one report related to Sterlet sturgeon (*A. ruthenus*) and Russian sturgeon (*A. gueldenstaedtii*) behavior in the presence of anthropogenic EMF, Basov (1999) found differing behavior at various E field frequencies and intensities:

- At 1.0 to 4.0 Hz at 0.2 to 3.0 millivolts/cm (mV/cm), responses were searching for source and active foraging,
- At 50 Hz at 0.2 to 0.5 mV/cm, response was searching for source, and
- At 50 Hz at 0.6 mV/cm or greater, response was avoidance.
- A study completed a year after the installation of submarine HVDC cables (1,300 A) in the Baltic Sea between Sweden and Poland detected no changes in the species composition, abundance or biomass of the area's invertebrate community (Andrulewicz et al. 2003).

For the Project area, a model of the expected declination from magnetic north expected from the cables (see Figures 1 and 2 above). For cables installed six feet apart at a four foot burial depth, at one foot above the riverbed there would be a maximum deviation of approximately 95 degrees within 10 feet of the cable, with no impact within approximately 40 feet from the cables. However, for cables installed next to each other (as the Applicants recently proposed), at one foot above the riverbed there is only a 35-degree declination within ten feet of the cable and the magnetic fields at all depths returns to background levels within 20 feet of the cables.

Exposure

A number of studies have investigated the effect of very strong magnetic fields on fish egg and larval development. Strand et al. (1983) reported that exposure of rainbow trout eggs, sperm, or fertilized eggs to a 1 Tesla (10,000 Gauss [G] or 1,000,000 milligauss [mG]) direct current (DC) magnetic field had only the slightest effect on the fertilization rate. Formicki and Winnicki (1998) reported that trout and rainbow trout embryos and larvae exposed to DC magnetic fields above 4 millitesla (mT) (40 G or 40,000 mG), exhibited incubation delays and longer and heavier bodies than controls exposed at levels up to 5.5 mT.

A weak increase in the permeability of egg shells of trout, rainbow trout, and sea trout to water was reported from ultrastructural observations of the shells after exposure to a 2 mT (20 Gauss or

20,000 mG) DC magnetic field in vitro (Sadowski et al., 2007). Sea urchins exposed to 30 mT (30 G or 30,000 mG) but not 15 mT (15 G or 15,000 mG) DC magnetic fields delayed development in early embryos and caused an increase in abnormalities of gut development (Levin and Ernst, 1997). Sudden exposure of carp embryos and larvae to DC magnetic fields of 50-70 mT (500-700 G or 500,000 mG-700,000 mG) is reported to increase heart rate by 5%, which then declined to resting levels in 15 minutes (Formicki and Winnicki, 1996). Trout larvae and fry tended to be attracted to magnets placed in experimental mazes that produced magnetic fields of 0.15-0.42 mT (1.5-4.2 Gauss or 1,500-4,200 mG).

Impacts from EMF

The Applicants have found no studies that demonstrated negative effects to aquatic life resulting from EMF (Bochert and Zettler 2006; Centre for Marine and Coastal Studies at the University of Liverpool 2005; Scott Wilson Ltd. and Downie 2003; Sound & Sea 2002; USACE 2004; Scottish Executive 2007; World Health Organization 2005; Hatch Acres 2006, Exponent and Hatch 2009). The USACE (2004) concluded that there would be no negative effects to fish species or the marine environment as a result of the 60 Hz B fields because the magnitude of the B fields proximal to the transmission cable would be limited to an extremely small space and decrease rapidly within a few feet of the cable.

In terms of migration, available information indicates that no single environmental stimulus, e.g., current flow, light, smell, taste, magnetic field, temperature, salinity, etc., dominates migratory behavior. Magnetic field stimuli seem ideal for navigating between distant regions, but locations for spawning and reproduction likely are determined by local, non-magnetic cues (Lohmann et al., 2008). Migratory species thus have the means to coordinate and make use of multiple cues and resolve discrepancies. For example, the orientation of salmon towards natal lakes in tanks without olfactory, taste, or current cues is not affected by a 90-degree shift in the horizontal component of the magnetic field during the day but is observed to change at night (Quinn, 1980).

Moreover, the magnetic field of the cable will accentuate or attenuate the magnetic field of the earth in a constant fashion along a narrow band of river bottom the length of the Hudson River as it will be aligned throughout this portion of the route in a constant relationship to the north-south pole magnetic of the earth. Other alterations to the geomagnetic field that fish and other fauna encounter in aquatic environments include magnetic anomalies in geologic sediments beneath sea and river beds, and numerous perturbations of the geomagnetic field by ferromagnetic objects on the bottom, e.g. sunken ships, gas and oil pipelines, communication cables with ferromagnetic armoring. Steel surface vessels will also significantly perturb the geomagnetic field as they sit at moorings or move through the water. Studies conducted in laboratories of prolonged exposure of marine fish and invertebrates to DC-produced B fields have not detected effects to orientation or movement compared to control organisms (Bochert and Zettler 2004, 2006).

Another important consideration is that, by and large, migrating fish species will not travel in the part of the water column closest to the buried cable. The strength of the field is greatest closest to the cable and diminishes quickly with distance. As migrating fish species tend to be in the

upper part of the water column (see Xie, 2002) and the average depth of the Hudson River varies between 40 feet in the southern section and 6 to 12 feet in the northern section (but with a 40-foot deep channel), the additional distance above the buried cables brings them into a region where the magnetic field characteristics will be closer to that of the earth's background geomagnetic field than at the river bottom. This separation distance diminishes the potential for negative effects on fish migration.

In evaluating the potential impacts due to exposure, the available literature indicates that there would be no adverse effect on egg and larval development. The Applicants' modeling predicted a DC magnetic field for 3652.7 mG at the river bed [Appendix B, Request 14 of the supplemental document submitted to the New York State Public Service Commission on July 22, 2010]. In contrast to DC magnetic fields that are reported to affect development at high intensities, delays in development are reported at lower intensities of 60-Hertz, alternating current magnetic fields (1,000 mG) in Japanese rice fish by Cameron et al. (1985) and sea urchins by Zimmerman et al. (1990). This data suggests that much greater magnetic fields are required than the proposed cable will produce, in order to create deleterious effects on eggs and larvae. In addition, as a percentage of the overall spawning numbers, the area of potential effect is small and extremely weak and would therefore represent a negligible effect of any kind on the number of eggs and larvae present during spawning.

It has been suggested that the research developed with respect to open marine systems may not be applicable to a river channel environment. However, a substantive change in the ambient geomagnetic field produced by the cables is confined to a limited distance around the cables. The DC magnetic field only will vary from a background level of 527 mG in the Hudson River by more than 20 percent within ± 16 feet on either side of a single cable and ± 4 feet on either side of cables laid 1.8 m apart at 20 - 40 feet above the river bed. In the lower estuary of the Hudson River where it is narrowest, this zone around the cable is a small fraction of the width of the river (about 5,000 feet) and as such is not likely to create a meaningful potential behavioral restriction within the cross sectional area of the river that fish would move through.

In summation, research studies on a variety of fish and other marine species have not reported adverse effects either in open marine systems or in small experimental tanks. The MMS has concluded that the B fields produced by the cables would not negatively affect marine life (MMS 2009). The World Health Organization (2005) reports that "none of the studies performed to date to assess the impact of undersea cables on migratory fish (e.g., salmon and eels) and all the relatively immobile fauna inhabiting the sea floor (e.g., mollusks), have found any substantial behavioral or biological impact." While it is not possible to "prove the negative", i.e. provide absolute assurance there will be no deleterious effect, repeated tests by multiple investigators have not shown any adverse effects at the relevant levels of exposure.